

OCTOBER, 1930

DEPARTMENT OF COMMERCE

UNITED STATES BUREAU OF MINES
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SCOTT TURNER

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DEPARTMENT OF COMMERCE - BUREAU OF MINES

THE MINERAL INDUSTRY AND THE YOUNG ENGINEER¹

By Scott Turner, Director,
United States Bureau of Mines

We are here today to witness the graduation of 63 young men as Engineers in the mineral industries. It is an important occasion and one in which the public takes a keen interest, since this school has long been famous for the educational facilities it affords young men, and for the high professional standing of its graduates.

It is fitting that once each year we should pause to review the path the student has traveled, and to reflect upon the perspective opening before him as an engineer.

I was invited to come from Washington to take part in this ceremony and to say something to these young graduates. In searching for a theme, it occurred to me that perhaps my best contribution would be to discuss certain beliefs as to college training, deal with the situation in which the young engineer finds himself on graduation, touch on the new ideas of the social and political responsibilities of the engineer, and point out what he may expect to find in practice, and, above all, what he must do to orient himself properly in the mining profession and maintain the best traditions of our brotherhood.

Let us first review your college days and see what they have done for you. I am told there are still many temptations in college. I know there used to be. Rest assured the same holds true in the professional life ahead of you. The main difference is, perhaps, that your greatest temptations in college were those offered by your teachers, who tried to entice you into realms of harder work, closer application, increased concentration, clearer thinking and better understanding, by animating your curiosity and increasing your powers of reasoning and of observation. In other words, here you have carefully and systematically been decoyed toward finer and loftier things. Do not expect that similar helpful influences will greet you on every side in your professional life. Often quite the contrary is the case.

1 Excerpts from address delivered to the Graduating Class of the Colorado School of Mines in Golden on May 16, 1930. The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used:
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You should have high moral qualities in college; character you must have if you are to become an outstanding engineer. As you left your homes to come to college, your adjustability was taxed and you sensed a greater independence than ever before; then you needed to be on your guard. In many ways, after graduation your power of adjustment is still further put to the test and you experience a still greater release from restraint. Now not only your personal life, but also that new and priceless possession, your professional reputation, must be cherished. Be doubly on your guard from this time on. Make no snap judgments as to right and wrong.

Try to change your point of view quickly, and adapt yourself to your new conditions. Before graduation, you received kindly suggestions from your teachers; you could complete work at your leisure or leave it incomplete; you could alternate excellent work with poor work, as the mood struck you. You could loaf and rest for a few days and later apply yourself to your studies; your instructors would help you a great deal if you wished it, and patiently and repeatedly explain things. Initiative was not required; you could work by and for yourself, in as individualistic a manner as you chose.

Now suddenly, on your first job, you probably must execute sharp orders without asking too many questions; you must uniformly do neat and accurate work at a high rate of speed, whether you feel like it or not; you will be expected to apply yourself vigorously, with no let-ups; you must go ahead and do your job entirely on your own; your value to your employer will be in part what you do under orders, and in part what new and improved methods and devices you can suggest. You must work cooperatively, and for the good of an organization.

Obviously, as outlined above, the two points of view are quite different, but the young engineer must quickly adapt himself to the change. Hence I say, adjust yourself to the new order of things with as little friction or delay as possible.

Study carefully the requirements of your chosen profession. Whenever feasible, make contacts with the leaders in your line; familiarize yourself with their biographies; reviewing their experiences may comfort you when you feel that your apprenticeship is difficult and your progress is slow. You must learn to estimate men, the meaning of personality, the strength and weakness of the individual with whom you come in contact, his purposes and motives, his ambitions and what he has accomplished, if you are to become an outstanding engineer.

Probably you all feel regrets at leaving college. You doubtless dread the separation from your friends. Many people like to think that college friendships are the best. I believe this myself; I know how fine and lasting they are. Such friendships, beginning at an impressionable age when youth, exuberance, vitality and the joy of living are coupled with lack of responsibilities and selfish aims, seem to be apart from all others. But do not be misled into believing that no new and precious friendships lie ahead of you. They are of a different kind, and depend largely upon effort, work, and accomplishment. The mining engineer is particularly fortunate in this regard. He is most apt to undertake difficult jobs in isolated or dangerous localities, where the technical staff may be small and the demands made on it may be heavy. Here the value of team work soon becomes apparent;

co-operative effort, even though it is not successful, so long as it is honest, earnest and patiently and hopefully sustained, leads surely to friendship.

We know that nothing throws people together like the unusual; unity may come at once from common task or mutual danger. A ship may be crowded with standoffish passengers who have journeyed together for days, perhaps, without speaking to each other; let something unexpected or startling occur and at once the passengers chat and visit and proceed to develop friendships. People living in the same block may in the course of years never have spoken to each other; let a fire, or earthquake, or some other common danger menace them, and at once they react in a friendly manner. Whenever a common cause makes combined exertion necessary, there we find the beginnings of friendships. What man is more apt to be called on to cooperate in difficult enterprises than the mining engineer? Who is more often asked to meet the unexpected, combat peril, and accomplish the difficult? Fighting against a man may lead to mutual admiration and respect, but I think the scars of battle still remain. Fighting side by side with a fellow-engineer, for a worthy purpose, even though you lose, leads to enduring friendship.

The first and inflexible rule you must now adopt is: Always keep fit. Good health is your primary requirement. When opportunity comes, you must be ready for any job in any climate or altitude. If you are sent abroad into a difficult region, you cannot afford to start in poor health. Even though you are employed near by in your own country, do not handicap yourself with the irritability and pessimism that come from ill health and disease.

The finest single byword you can follow as an engineer, is the same that you followed as a student, that is loyalty. Up to now it has been loyalty to your athletic team, your fraternity, and your college; from now on it will be loyalty to your profession, to your employer, and to the engineering group of which you may be a part.

Not so many years ago, business was conducted on a pitilessly competitive basis. The old notion of smart business was a deal in which one man got the better of another. The new idea is a transaction which is beneficial to both parties. The recent order in engineering is co-operation. I need not elaborate on this point, since you see cooperative business on every side. Recognize early in your professional life the necessity of harmonious action. Join the technical societies or institutes most closely identified with your work. Exchange personal knowledge and experience, by writing technical articles and taking part in scientific discussions.

You will note I have said: Write technical articles. I earnestly advise it. Do not be ashamed to begin. The young engineer often feels he is not competent to write. Try it. The only way to learn to write, is to write. You will be astonished at how quickly you improve. It has been demonstrated that the surest way to learn everything concerning a subject is to write about it. Putting your ideas or experiences in writing tends to crystallize and clarify them. Before you can write clearly, you must think clearly. You hear much nowadays of the glories of self-expression. I urge you to apply this to your technical experiences.

I know a number of cases where technical writing has brought a young engineer to the attention of important employers, and led to engagements which profoundly influenced his ultimate success. Diffidence in this regard is inexcusable; share with your fellow-engineers your thought, knowledge, and experience. Help them at the same time you help yourself. The best recent example I know, in this matter of willingness to write and give to others detailed engineering knowledge and experience, is shown in the fine cooperation now being displayed by the leading engineers of this country by preparing, for publication through the United States Bureau of Mines, scores of papers on mining and milling methods and costs. I recommend to you the helpful spirit which made possible the production of these papers.

On graduation, do not scorn the lowly job. Be content at first to work constructively at the bottom of the ladder; in due time, you will work upward. Later on, a few of you may find yourselves at the top, whence all others will want to pull you down. Probably you will find more satisfaction in working on some engineering project or mining development which is incomplete or unsuccessful, and helping to finish it or pull it out of the hole, than you will in merely joining the staff of a well-established and successful venture of long standing. The former is pioneering; it appeals to the creative instinct so strong in us, and offers romance and adventure. The latter means only becoming a small cog in a well-oiled and smooth-running machine. I strongly urge you, either individually or in groups, to give your creative faculties a chance while you are still young. This does not necessarily mean to undertake exploration or development work in foreign lands, or hazardous adventures, but it may mean to assist in making successes of new or doubtful enterprises, whereby you may feel the keen thrill of winning against odds. Play the hard games in your youth; treat obstacles as summonses to fight; defy obstructions, and do not let impediments turn you aside.

When I graduated from mining school, more than 25 years ago, it was difficult to find a job. As I recollect it, only three men out of my class of 44 got track of jobs through the school. The other 41, many of them with slender financial resources, and with very small acquaintance with mining men, were turned loose on an unfeeling world already overcrowded with engineers. Common labor was the only work open to many, and often they had to travel hundreds of miles to get that. Only the more determined men continued the struggle. Perhaps starting at the very bottom and taking some hard knocks was good training and developed manual skill and self reliance. Undoubtedly one learned to measure a day's work and to understand the viewpoint of the unskilled laborer, the miner, or the millman. However, when lowly jobs are too long continued, an economic waste is undoubtedly involved. I am sure I pushed a mine car, swung a shovel, and pounded a drill, long after I had mastered their use. By reading and listening to discussions about employment for graduates, I learn that all this is now changed, and that the demand for young engineers often exceeds the supply. This is an admirable improvement, provided the recent graduates can stand prosperity of this kind, without acquiring a cocksureness, an exaggerated sense of their own importance, and a predilection for white-collar jobs which may in the long run militate against their usefulness.

Likewise, three decades ago, much time was lost when it became necessary or advisable to seek a new job. Days, weeks, or even months of "rustling," unprofitable days spent calling on mining men or visiting offices in various camps and cities, were considered inevitable and a necessary penalty for practicing the profession of mining engineering. Now, when the world has generally come to recognize that irregular employment is the worst and most universal of all industrial evils, I am pleased to learn that, through better organization for placing technical men and improved employment facilities in the colleges and societies, and through quicker communication and exchange of employment news, the economic waste attendant on professional idleness is being eliminated.

When inaction is compulsory, put in the time you can spare from soliciting employment, or use the periods when you are waiting for a decision from prospective employers, in broadening your professional acquaintance, in visiting mines and plants, in attending meetings and conventions, in taking part in engineering discussions and in writing technical papers. Thus what might otherwise be lost time may actually be turned to ultimate advantage.

I am told that colleges are now in close and constant contact with industry; I used to feel that they were not, and that the technical schools kept a certain aloofness, paying little heed to its rapid progress, constant change, and real needs. Nevertheless, as I have before suggested, the recent graduate is apt to find the leisurely pace of college too slow for industry. The speed, initiative, accuracy, snap, and drive required of him in business are new to him, and while the habit of work may have been formed during the college course, still it was not the sustained and exacting work required of the practicing engineer. During the college year, the student could generally set his own pace. Things did not change much; no new conditions had to be met suddenly; emergencies were rare. On the other hand, methods and practices in the commercial world often must be changed so rapidly, to keep abreast of industrial competition, that hard, accurate thinking and quick decisions under pressure are required. From loitering theory to rapid practice is a sudden change for the young engineer, but again I shall remind you that he must speed his pace and never be content to lag behind.

In industry, profit is frequently a small difference between income and outgo; early training in maintaining a proper balance between the two will help you toward commercial leadership. The mental habits of youth are likely to be always with you. You are fortunate if the proper meaning and use of money were taught you during undergraduate days. I hope that it is already instinctive with you to keep track of and analyze your personal receipts and expenditures. In practice, you will need to apply such a faculty before you can properly manage a mine. Have pride in your financial efficiency, and when you spend money, get a commensurate return for it. The engineer judged to be successful may be the engineer who knows how to make a little go a long way, who knows how to get his money's worth. The engineer-student who has had but moderate means or opportunities, but who has accomplished much, has had fine training for future mine operation. No matter what certain successful automobile manufacturers or victorious politician-economists tell you, disregard advice to keep on spending; instead, adopt the seasoned faith as to the need for saving, and never spend all that you make.

At various times during his career, every engineer is required to pause at cross-roads and decide which course to take. Obviously this decision will directly affect his future professional career. For instance, I remember a Friday in London many years ago when I carried in my pocket three proposals, with the following Monday set as the final day of decision. One job would take me to a copper mine in the high Andes in the Argentine republic; one would lead me to alluvial gold workings in Eastern Siberia; and the third necessitated going to coal mines 700 miles from the North Pole. On my decision rested the future trend of my professional work. Most of you will find yourselves in similar predicaments. How are you going to decide? I know this question will puzzle you, but remember there are only two methods of approach. Study the facts, and ask others for advice. I need not here elaborate on these points. Your final decision must be made alone, perhaps almost involuntarily, and will always involve the element of chance. Analyze all available information, interview your hardest-headed friends, take wise counsel; then decide quickly, and make up your mind never to regret the choice.

Let us turn back to the question of college courses and consider the possible bearing of early training on the much-discussed problem of the engineer as a citizen. It has been considered that the training of an engineer is too often vocational training; that it is a pity all engineers cannot have had a period of liberal training before taking up pure engineering. Offhand, the so-called liberal courses should bring more ready adaptability to deal with the unexpected, to face with assurance situations which have had no parallel in one's experience, and to move without hesitation under conditions which were heretofore unknown to one, than the specialized course in mining engineering.

We hear increasing talk as to the necessity of making the engineer articulate, and bringing him into public life. The social implications and responsibilities of engineering are pointed out, as of equal importance with the prodigious marvels of engineering ingenuity. You often read of this as the logical result of the increasing consciousness of the engineer as to his relative position in our modern industrial civilization.

Some wag has noted that man is the noblest work of God, but that man is the only one who has said so. Perhaps engineers are the only claimants as to the necessity of their going in for public life and service; at any rate, some liberal educators still maintain that a well-rounded general education is the better training.

While the engineer may have contributed to the new social and economic order, in addition to having materially bettered his professional technique, let us not go beyond the bounds of reason in estimating our importance in public life. The keenest engineer, when elected to public office, may have to subordinate many of his professional ideals, put aside and forget various of his engineering habits, and adjust himself to the new job so completely that we might see in him few of the characteristics of the professional engineer. In fact, to do his job, he must become something of a conventional public man. He may face the necessity of substituting compromise and broad adjustment for the rigid rules of straight engineering. Expediency may have to be his new watchword, rather than accuracy.

and engineering truth. To me, the prosperous engineer who relinquishes his profession and becomes a successful public administrator, demonstrates his adaptability and general competence rather than his technical skill. His engineering education and experience may have fitted him for his new field of activity, but let us be a little cautious in insisting that engineering principles and ideals are being rapidly introduced into public life. Why not simply stick to it that a liberal education, plus an engineering course, makes for the most adaptable and useful citizen? We can still with reason claim that the introduction of more engineering into government is good.

A Member of the Congress of the United States recently listened to my complaint as to the difficulty of placing facts before a Congressional Committee. He said that the trouble with engineers is they think everything should be judged, and legislation should be passed, solely on the basis of engineering fact. Actually, he said, the Congress may properly be more interested in what the people want than in the facts. Often the two are wide apart, and in such cases, facts alone may not govern legislation. This man put into words what I had noted but had not understood - that science, which deals with facts, must sometimes be disregarded for what is pleasing, for what is desirable, and for what is popular. Thus legislative action might be based more on knowledge of public sentiment, than on facts and their interpretation.

I believe it behooves the engineer, individually and through his technical organizations, to come forward when facts are needed, and thus assist in protecting the legislator and the public from the passage of unwise measures. Of course the engineer is exercising more and more influence in the choice of competent men for public office - but let us not delude ourselves by thinking that in matters of State, political processes are rapidly giving way to engineering methods.

The mining engineer is perhaps freer than any other engineer from the charge of having created many serious social problems by the introduction of new devices. In the mines, improvements in practice resulting in increased tonnage have often been accomplished by exercising ingenuity in taking advantage of natural conditions. However, the present rapid trend toward mechanization, particularly exemplified to-day in coal mines, may compel more careful study as to the resultant social effects; thus a tendency to change from the individual or group to the machine may necessitate more attention to the humanities, which appears anomalous.

On every hand we hear comments on the so-called mechanization of life. I do not feel this movement is new; I believe it only a more rapid development of a trend that has been apparent since the dawn of history. I am not afraid that our cultural, industrial, physical or social lives are to be abruptly changed by an apparent industrial revolution. Always man has tended to mechanize. The discovery of the principle of the wheel - a principle not even known to such typical Americans as the Incas or Mayas even in the time of Pizarro - was a great step toward mechanization. The hinged rudder and the tiller evolved from the old Scandinavian steering-board, were marked changes in navigation. The Morse

telegraph was not much of a change from the savage tom-tom and the code message of the jungle drum. Mechanization is proceeding rapidly, but so are our social and industrial needs. Larger groups of people are now more rapidly and completely affected by mechanical changes, but the rate is not out of proportion to other changes that are taking place, and perhaps primitive man tended to mechanize nearly as rapidly as we do, when his status in relation to other matters is considered. Therefore, I am not fearful that man will become slave to, rather than master of, the machine. The last 30 years have brought about greater changes in mining and metallurgical methods than occurred in say the 2,000 years immediately preceding. But do not forget that the more rapidly things undergo variation, the more ready the world is for alteration and the more eagerly will it accept change. When you, by research and experimentation, are seeking new methods, and improvements in old ones, bear this in mind. Never before in the history of the world has the mining industry as a whole been so ready, willing, and eager to adopt new operating ideas. You therefore have opportunities greater than any engineers who have come before you. Let this thought be a challenge to you.

The young engineers graduating this year from various colleges constitute the annual influx into the profession and are just now of especial importance to the mining world; this is because of your unspent years, your abounding vitality, your unexhausted energies and unused strength, and your limitless possibilities. Do not be offended if sometimes you hear youth described as optimistic and visionary; occasionally loutish, stubborn and ignorantly insistent. You, being the youngest engineers, have the longest engineering lives ahead of you and are therefore of maximum importance and value. The motive power for national and world engineering achievement comes from men of your kind, filled with enthusiasm, energy, eagerness and optimism.

You are now ready to experience and to give answer to the call of what is best in the engineering occupation. As you move forward, retain your high ideals. Join us in keeping untarnished the record of the mining profession, and at the same time, not content with things as they are, insist on raising the tone of our calling by bringing to it your youthful creative spirit, all your hopes, enthusiasms, visions, inspirations and contagious power. Now, as always before, everything depends upon the coming generation. Our demands on you will be heavier than requests ever were before, since we hand on to you more difficult and onerous problems and greater moral and financial responsibilities than have previously fallen to the lot of such youthful engineers.

The art of engineering is never static. Processes of development are always operative. You should be less likely to err than those who have gone before, but more fallible than those who come after you. The last word on the ethics of engineering has not yet been spoken. Progress involves continual revaluation of customs and beliefs; the less perfect must be modified; the best must be tenaciously perpetuated. Now, as never before, must we apply high-grade intellect and fine moral consciousness to what to some may seem the commonplace and apparently uninteresting business of wresting from the earth's crust the fuels, metallic ores and industrial minerals so indispensable to civilization.

Deep and comprehensive mutations in engineering will come, and for perhaps three decades you of this generation will be responsible for them; you must steadily and rapidly develop yourselves in order that broader understanding, more intense study, and more ingenious schemes may always be forthcoming from the new generation, to carry upward the standards of engineering.